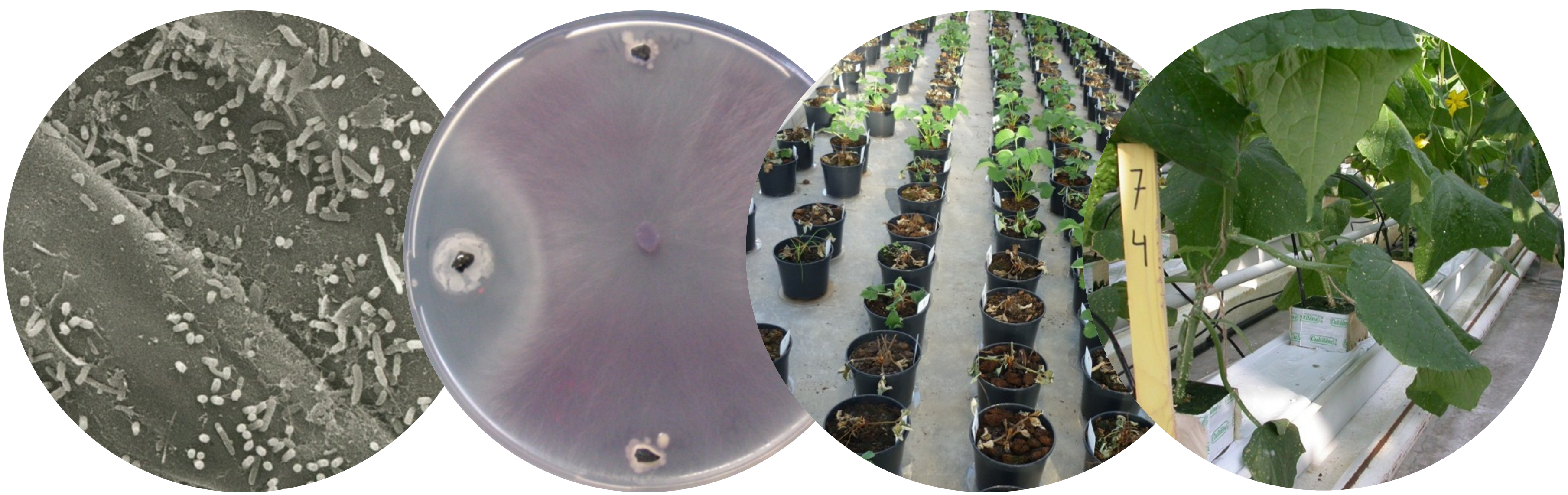
Suppression of soil-borne plant pathogens in horticultural systems through microbial interactions

Joeke Postma – 07/03/2013



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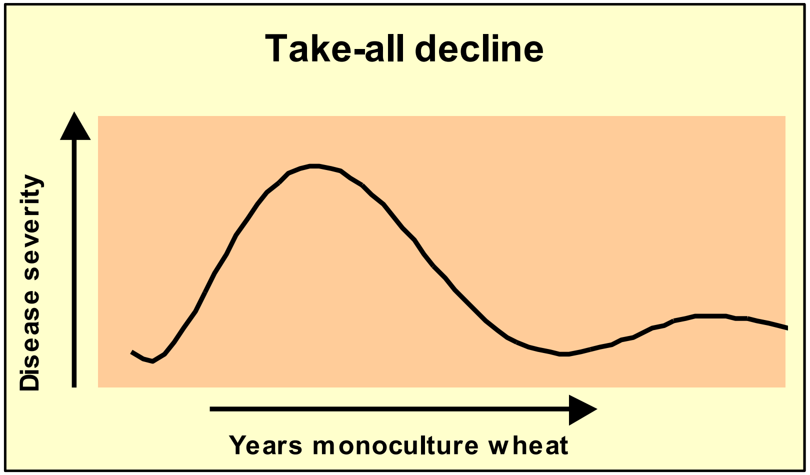
Overview

- Disease-suppressive soils
  - Enhancement of suppressiveness in natural soil
- Soil-less systems
  - Enhanced suppressiveness
  - Biological control
- Summary

Disease-suppressive soils

Many examples:

- Take-all decline: reduction of *Gaeumannomyces graminis* (Raaijmakers & Weller, 1998)
- Pythium suppressive soil (Lifshitz, Stanghellini, Baker, 1984)
- Fusarium suppressive soil (Alabouvette et al., 1979)
- Rhizoctonia decline (Postma et al. 2010)

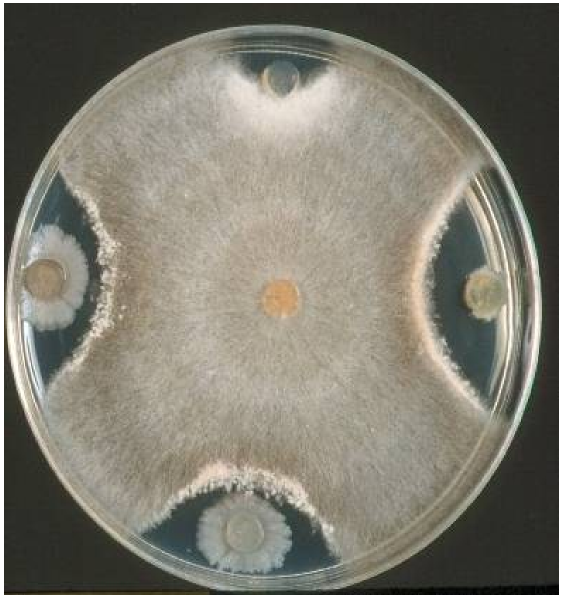


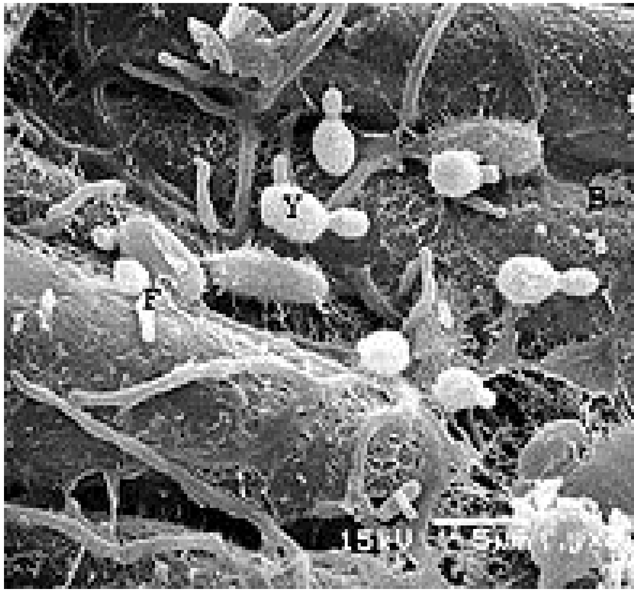
Conducive & suppressive soil

Mechanisms of disease suppression

- Abiotic conditions: structure, moisture, pH, ...
- Biotic interactions: soil is full of organisms competing for nutrients and space!


parasitism


antibiosis


competition

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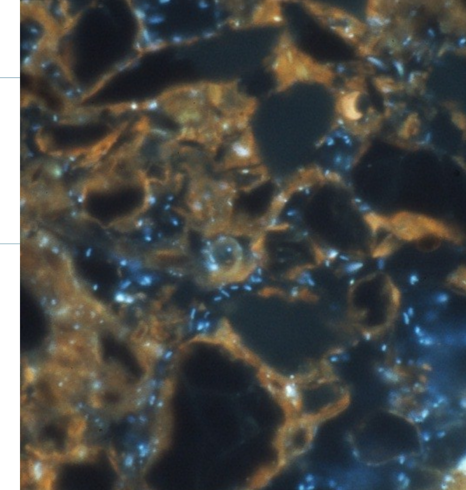
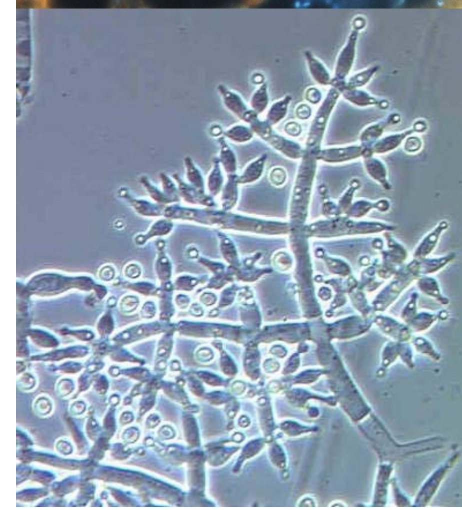
“living soil”:

- Bacteria: 10^7-10^9 cfu/g soil ; 5000-14000 species
- Fungi: 10^5-10^6 /g soil ; 50 m/g
- Algae: 10^5 /g soil
- Protozoa: 10^4 /g soil
- Nematodes: 10^2 /g soil
- Arthropods: 2-5 10^4 /m^2
- Enchytrae: 4-20 10^3 /m^2
- Earthworms: 0-1 10^3 /m^2





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Enhancement of soil suppressiveness

Use the natural treasures of the soil!

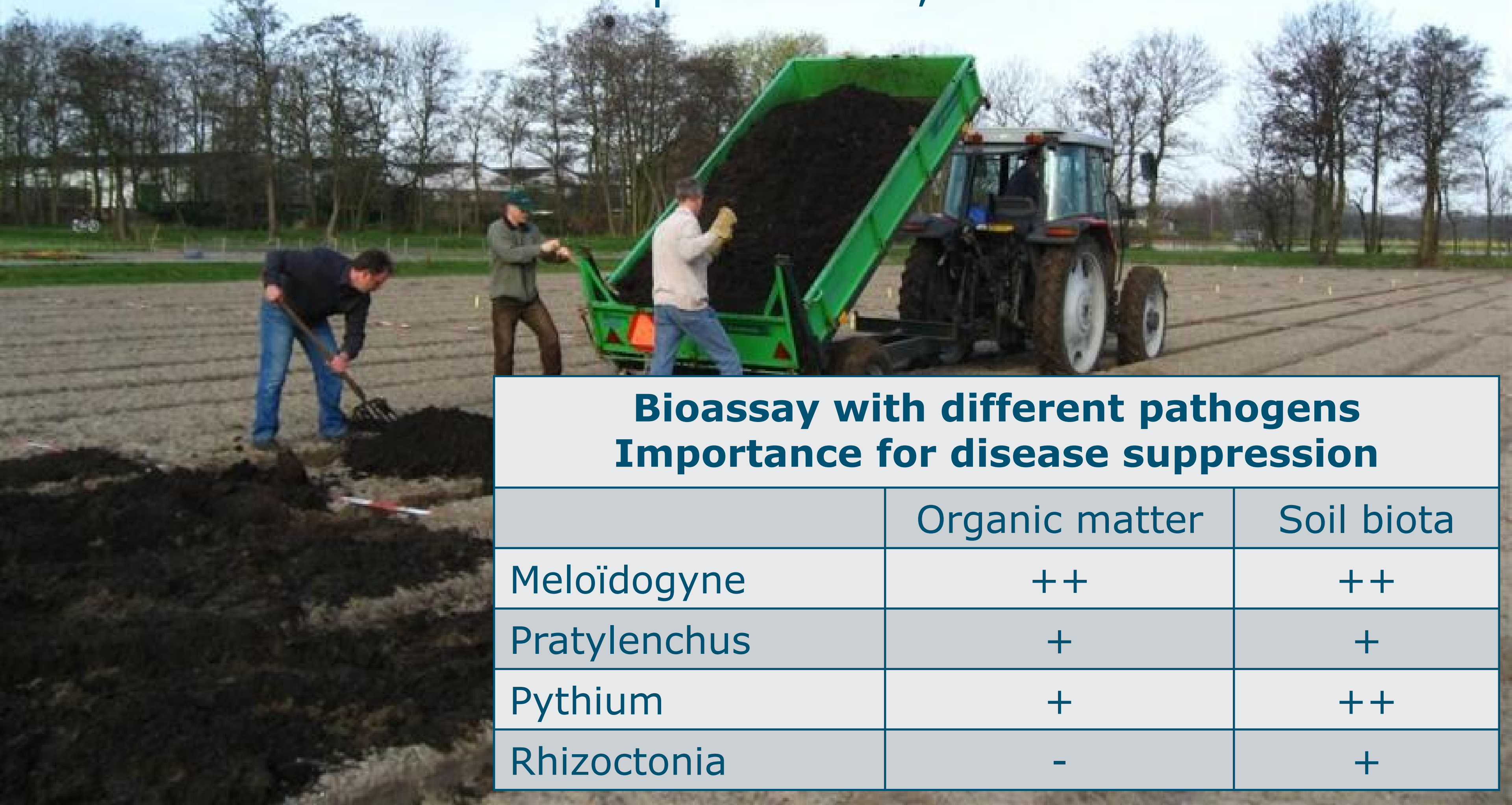
- Enormous diversity of beneficial soil organisms
- How can they be stimulated?
- Can soil suppressiveness be enhanced?

Difficulty:

- Pathogens are sensitive for different mechanisms
- Management has different effects on different pathogens

Example 1: organic matter

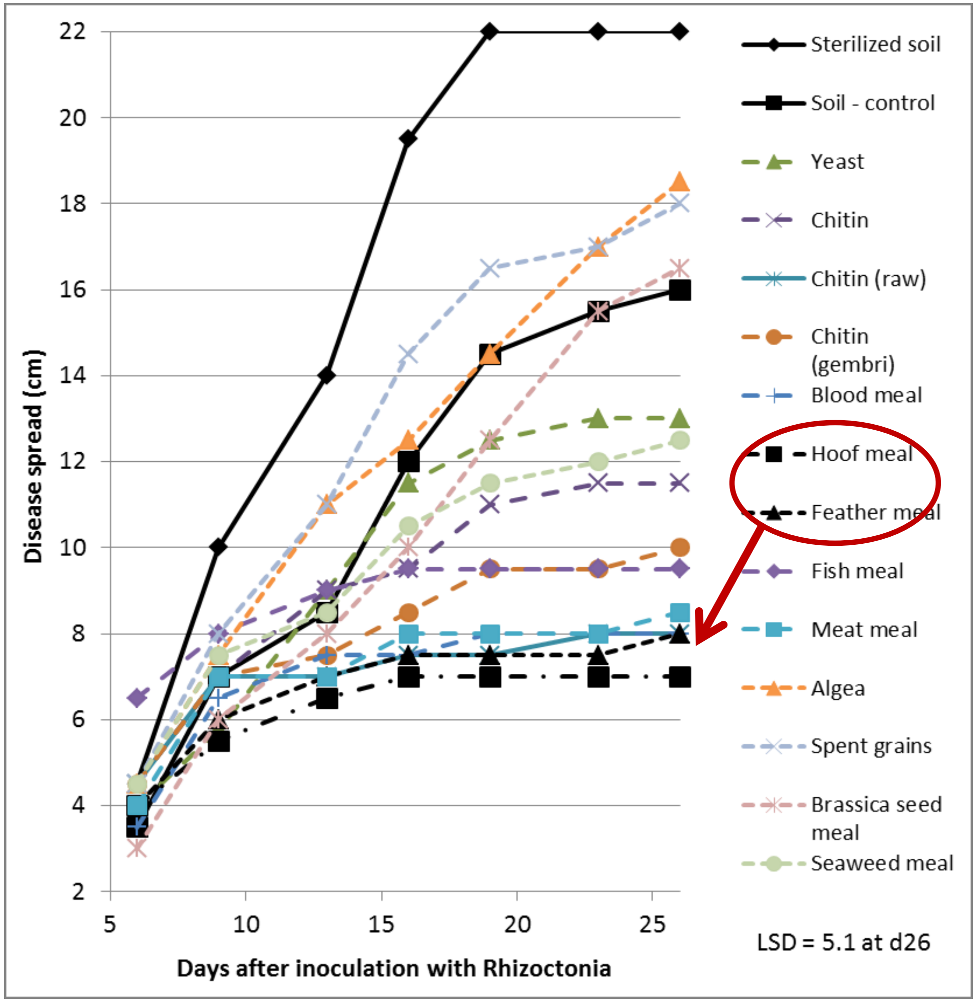
- "Topsoil" experiment at PPO-Lisse (Gera van Os)
- Dune sand and added peat: 0.7%, 1.4 and 3 % OM



Bioassay with different pathogens
Importance for disease suppression

	Organic matter	Soil biota
Meloïdogyne	++	++
Pratylenchus	+	+
Pythium	+	++
Rhizoctonia	-	+

Example 2: specific organic compounds



- Enhanced disease suppression of *Rhizoctonia solani*
- With yeast, chitin, animal waste products
- Not with plant-derived materials

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Soil-less systems

Advantages:

- Independence on soil type
- High yield
- Increased quality of products
- Better control of growth
- Pathogen free start !!!

Disadvantage:

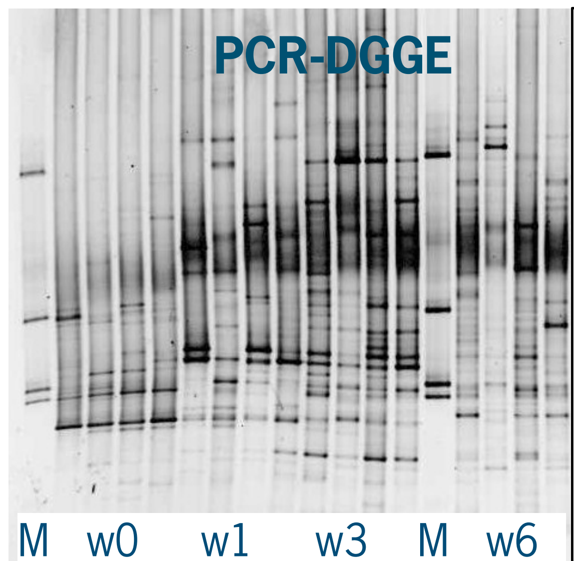
- Sensitive for infections!!
- No/poor microbiological buffering capacity

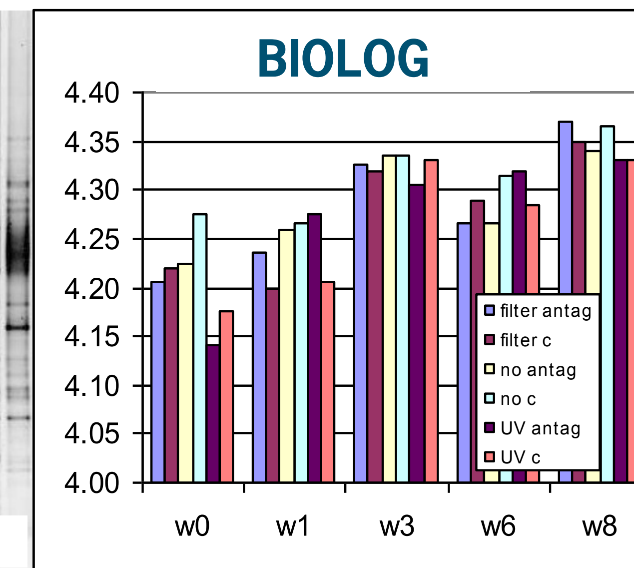
Microbial populations in substrates

Substrate	Culturable bacteria	Remark
Natural soil	10^8-10^9 CFU/g	Enormous diversity; strong competition between MO
Fresh peat New rockwool	10^4-10^8 CFU/g 10^4-10^6 CFU/g	No plant related MO: no pathogens, no beneficials

Diversity: low

Fresh substrate lacks biological buffering capacity





EU-MIOPRODIS 2001

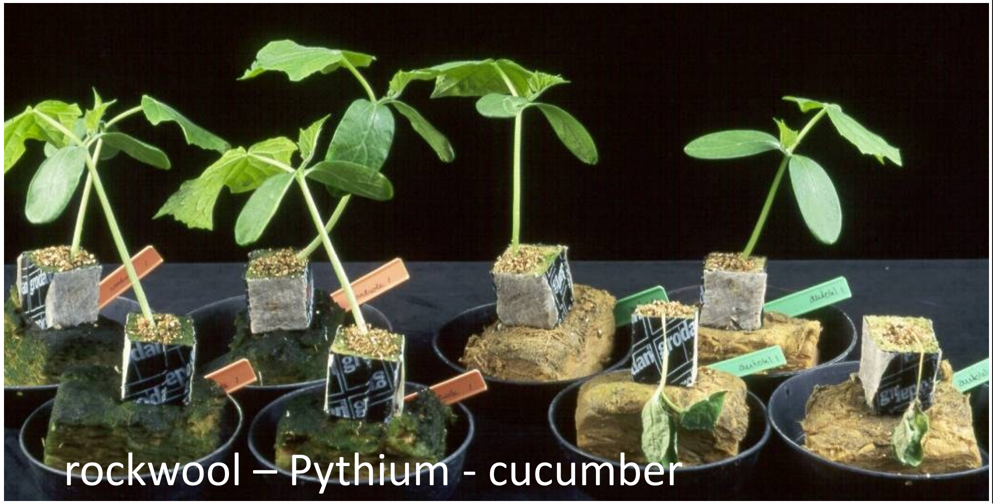
Challenge:

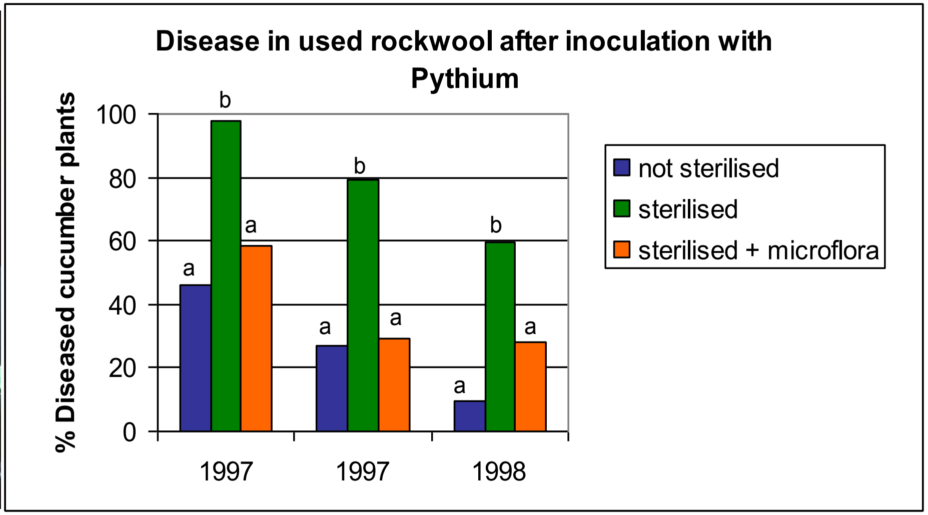
How to enhance suppressiveness in soil-less systems?

- Improved physical and chemical conditions
- Microbial enrichment: used rockwool is often suppressive
- Search for suppressive substrate and identify the suppressive component
- Addition of biocontrol agents
- Addition of plant strengtheners or elicitors

Suppressive substrate

- Used rockwool is suppressive to *Pythium aphanidermatum*
- Suppressive microflora can be translocated to sterilized rockwool
- Suppressiveness correlates with bacterial diversity & CFU of streptomycetes





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(Postma et al, 2000, 2005)

Biocontrol of Pythium in rockwool

- *Lysobacter enzymogenes* 3.1T8
- Isolated from cucumber root tips grown in disease suppressive rockwool
- Surfactant, protease, lipase, chitinase
- Antibioticum: dihydromaltophilin
- In vitro: inhibition of Pythium growth
- Effective control of *P. aphanidermatum* in ebb & flow system
- No commercial product

Folman et al, 2003
Postma et al, 2009
Nijhuis et al, 2010

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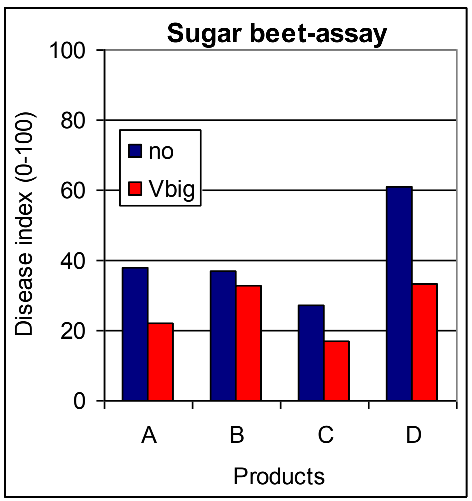
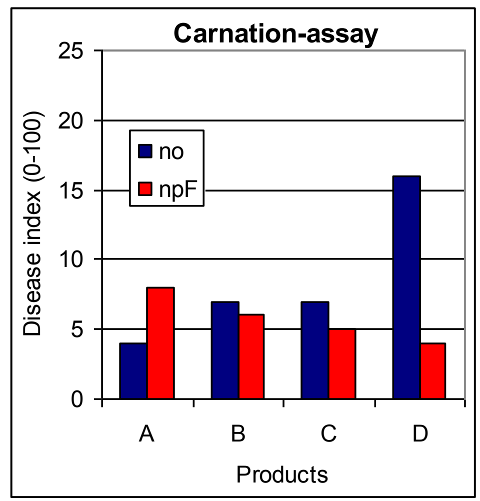
Biocontrol & compost

- Reduction of disease by compost (20%) added to peat
- Reduction of Rhizoctonia with *Verticillium biguttatum*
- Reduction of Fusarium wilt with non-pathogenic *Fusarium oxysporum*





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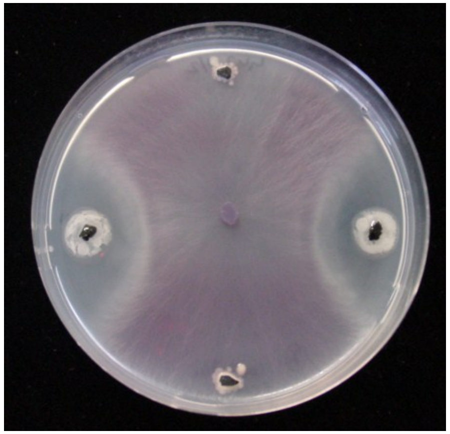
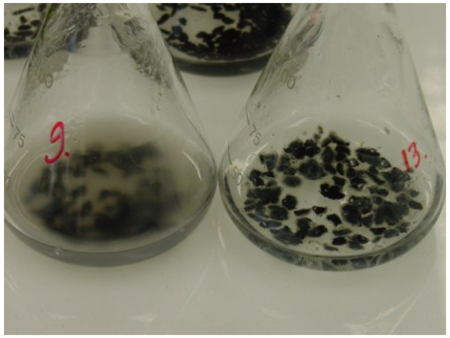
Postma et al, 2003

Biocontrol combined with P-mobilisation

- Selected bacteria:
  - Antagonistic against plant pathogens
  - Phosphate solubization capacity
  - Root colonization
- Controling Pythium and Fusarium in tomato bioassays





Postma et al, 2010. Applied Soil Ecology

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SEVENTH FRAMEWORK PROGRAMME

Organic substrate

- *Phytopthora cactorum* in strawberry plants
- Improvement of substrate, e.g. addition of compost ?
- Controlling disease with antagonistic bacteria/fungi ?
- Antagonistic bacteria are present in the rhizosphere
- Difficult to control Phytophthora!

Summary

	Pathogens can be present	Pathogen-free plant material
Soil: crop history & infections	Symptoms depend on suppressiveness of the soil	Healthy crop, limited crop damage by pathogens present in the soil
Substrate: new & clean	Pathogens can spread dramatically; e.g. young plants from outside	Healthy crop as long as infections are avoided Disaster when infection occurs

Create disease suppressive substrate !!

Thank you for your attention